(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
5 June 2003 (05.06.2003)

PCT

(10) International Publication Number
WO 03/046271 A1

(51) International Patent Classification[7]: D06F 37/20, 35/00

(21) International Application Number: PCT/TR02/00068

(22) International Filing Date:
29 November 2002 (29.11.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2001/03478 30 November 2001 (30.11.2001) TR

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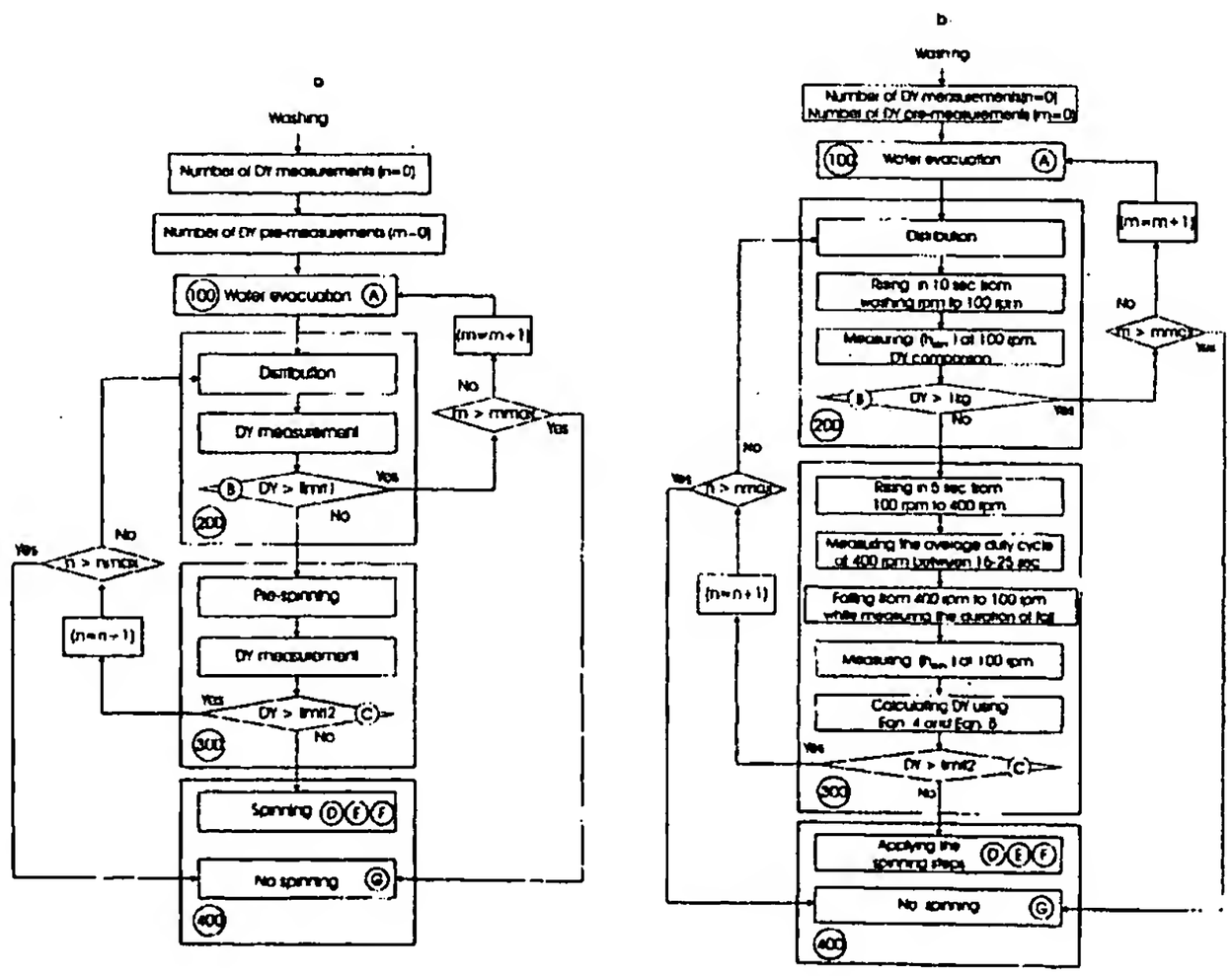
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

[Continued on next page]

(54) Title: METHOD FOR DETERMINING UNBALANCED LOAD



(57) Abstract: The present invention relates to a method for determining the unbalanced load in the domestic appliances, preferably those of the front-loading type, for increasing the capacity of the total load and when the speeds exceed the high revolutions, comprises the discharging (100), distribution (200), prespinning (300) and spinning (400) cycles and which enables the selection of spinning profiles that are suitable to the unbalanced loads (DY) obtained by precise unbalanced load measurement depending on the balanced load by interpreting the data received from the motor, according to the experimental data recorded in the data storage unit.

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— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

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METHOD FOR DETERMINING UNBALANCED LOAD

The present invention relates to a method for determining unbalanced load, which provides an efficient operation of the washing machine by determining the unbalanced load created by the uneven distribution of the laundry being washed in the tub, during the spinning cycle.

In the domestic appliances, preferably in washing machines, the rotational axis and the center of gravity do not match with each other when the clothes in the drum which are stuck to the inner walls of said drum by the centrifugal force, are not distributed stably. The dangerous centrifugal forces that occur in this case, may cause an overstrain of the washing machine strength, formation of harmful vibrations and even the moving of the washing machine itself.

In one of the prior art embodiments, the unbalanced load occurred due to the distribution of the laundry in the rotating drum during the spinning cycle, is determined according to the unloaded drum reference. The unbalanced load accumulated at a certain area in the drum, looses its potential energy due to the gravitational force, during the downward movement of the drum and produces a moment, which is directly proportional with the distance of the unbalanced load from the center of rotation. Whereas when the unbalanced load is raised upwards, it gains potential energy and the motor generates additional moment that is proportional with the distance between the unbalanced load and the center of rotation, in addition to the torque required to drive a balanced system. Thus, as the potential energy of the system increases, its speed decreases and the amount of current drawn from the motor increases; whereas, on the other hand, as the potential energy of the system decreases, its speed increases and the amount of current drawn from the motor decreases. By making use of this feature, the measurement can be made at low rpm drum speed values such as 100 rpm at

which drum speed, the sticking of the laundries to the inner peripheral wall of the drum is ensured; and the principle of calculating the variation of speed oscillations in direct proportion with the amount of unbalanced load, is evaluated by waiting for a certain time and inputting an error band, and then estimating the amount of the unbalanced load. As each unbalanced load creates a different standard deviation, this serves for determining whether spinning cycle will be started or at which maximum speed the spinning can be performed.

This method, which is currently used, gives the results that are deviated from the actual values with the drum containing balanced load. Inertia increases as the amount of balanced load increases and the speed fluctuations created by the unbalanced load moment decrease in line with above-mentioned increase. In other words, as the balanced load increases, the standard deviation of 100 rpm to occur due the same amount of unbalanced load, decreases and consequently said unbalanced load is detected as if it were less than its actual amount, according to the values set for the empty drum reference system and erroneous results are obtained.

In DE 19610189, determining the spinning speed according to unbalanced load is described. In this document, the spinning speeds are applied starting from the lowest value and the average voltage reapplied at a certain speed is calculated. As this value will provide a notion about the unbalance, then, it is determined whether the next higher spinning speed can be applied or whether a distribution is required or not.

In DE Patent Application No. 19832292, load is estimated by raising the laundry to a certain angle and by reading the maximum current drawn at that moment in a direct drive structure in a direct drive structure or by applying voltage until a certain current is attained, then observing the angle reached at that current.

In EP Patent Application No. 1113102, total load and unbalanced load are determined by signals obtained from the motor.

In EP Patent Application No. 0709512, the amount of load is deducted from the speed oscillations during the pre-washing cycle.

In German Patent Application No. 4336349, the inertia of the amount of wet laundry is determined by means of a spinning procedure.

In USA Patent No 6029299, the amount of load is determined by examining the speed profiles during washing. In this description more frequent and softer waves represent a large amount of laundry whereas less frequent and sharper falls and rises indicate a smaller quantity of laundry. This is understood from the rising and then falling of the laundry in the drum.

In USA Patent No 6032494, before the spinning, different distribution speeds applied at different loads, for providing the optimum distribution and the minimum distribution.

In USA Patent No 6038724, a way of estimating the load based on inertia-speed, in a washing machine of a top-loading type with a vertical axis.

The object of the present invention is to develop a method for determining an unbalanced load depending on the amount of laundry loaded in washing machines, which ensure a safe operation of the washing machine particularly during the spinning cycle.

The method for determining unbalanced load, realized to attain the object of the present invention has been illustrated in the attached drawings, wherein;

Figure 1a, is the flow chart of the method for determining unbalanced load,

Figure 1b, is the flow chart of an embodiment of the method for determining unbalanced load,

Figure 2, is a graphic showing the number of cycles and steps in the method for determining unbalanced load.

The domestic appliances, preferably washing machines of a front loading type, are provided with a drum in which the clothes to be washed defined as "the load" are placed and which performs the washing and spinning procedures by rotating about an axis, and an electronic control card that provides control. Said control card comprises at least one micro controller and at least one internal/external data storage unit. The data storage unit may be an external unit on said control card or may be an internal unit within the micro controller, such as RAM; ROM; EEPROM. In the preferred embodiment, data is recorded on a ROM included in the micro controller.

In cases when the total load capacity loaded into the drum increases and when the spinning speed rises above 1200 rpm, a detection method that provides an accurate measure of the unbalanced load by analyzing the data collected during the operation of the machine, by the help of the control card, is used in order to ensure an efficient, safe and undamaging spinning operation of the washing machine.

In the unbalanced load determination method according to the present invention, all measurements taken for the working of the method are evaluated with the data obtained by means of a tachogenerator connected to the engine driving the drum. The tachogenerator with more than one pole is defined by the double pole noof the tachogenerator (TK), which is equal to the half of the no of poles. Potential generated from the tachogenerator is converted to square waves and then is used to calculate the frequency. While calculating the frequency, in addition to the no. of tachogenerator double poles (TK), the belt-pulley spin rates (KKO) which is equal to the ratio of the diameters of the pulleys (R/r) in order to define the effect

of the drum with a diameter (R) being rotated by a motor with a drum with a diameter (r), is also used. As the frequency is directly proportional to the speed measured, the speed data obtained from these values are transmitted to the microprocessor.

$$\text{Frequency} = ((\text{rpm})/60) \times (TK) \times (KKO) \qquad \text{(equation 1)}$$

P1 controller arranges data with determined periods or frequencies for calculating the firing angle and dutycycle and then the motor is driven. In this manner, the motor rotates at desired cycles and the data obtained from the motor can be interpreted in a time-dependent manner in order to be used. The microcontroller is also provided with a memory containing the experimental data determined in the production or design stages entered by the manufacturer, so that the data received can be compared and interpreted.

The unbalanced load determining method according to the invention, detects the unbalanced load in relation with the balanced load present in the washing machine. Said method, by determining correctly the balanced and unbalanced loads during spinning, enables the spinning cycle to be performed at spinning rates wherein the centrifugal forces and vibrational amplitudes to be created by the balanced and unbalanced loads are within acceptable ranges, and/or provides a more efficient spinning performance.

The unbalanced load determining system comprises the steps of; water discharge (100), distribution (200), pre-spinning (300) and spinning (400). Said method brings the unbalanced state of the load in the machine to a balanced state, in the distribution step (200), then starts the spinning operation, determines the unbalanced load by checking the speed variations and motor potential profiles obtained during the pre-spinning step (300) and provides a safe spinning during the spinning step (400) according to the unbalanced load values obtained.

In order to calculate the number of distributing cycles (m) and the number of pre spinning cycles (n) to be performed after the washing cycle, the initial values of the number of distributing cycles (m) and the number of prespinning cycles (n) are defined as "0" by the control card. In the unbalanced load determining method that is started after identifications, water in the drum of the washing machine is drained before each spinning, until it falls below a certain level (100) (A).

Then the steps of rotation in clockwise direction at the speed of washing cycle (201) to continue the pump operation, rotation in counter-clockwise direction at the speed of washing cycle (202), stopping and waiting (203) are applied at different times with different durations, in order to realize the distribution of the laundry. Following the distribution movement, a spinning test speed that is much lower than the resonance spinning speed but able to provide the sticking of the laundry to the peripheral walls of the drum is attained (204) from the washing speed with a low acceleration, in a long time range; and a distribution step (200) is performed at this test speed that is kept constant for a certain time range (205), during which step, the change in the speed values measured sequentially is compared to the data obtained in the experiments made during design and production stages, in order to make the first decision about the amount of the unbalanced load. During this distribution step (200) the discharge pump operates continuously and evacuates water when required.

When the test speed (205) is reached, the drum is given a short time to run in the test speed and it is checked if an absolute deviation from the test speed has entered a certain range. Thus after ensuring that the drum is running in the test speed, speed measurements are taken along the "k" number of revolutions in order to obtain sufficient statistical data and the desired unbalanced load differentiation. While taking speed measurements, the required measurement number is obtained by using the function N (k) formed by the coefficient of the tachogenerator value and the belt-pulley revolution rate. Absolute value deviations of the speed values measured (hi) from the test speed (h_{test}) are calculated ($I\ h_i - h_{test}\ I$). Thus, the

deviation ($h_{deviation}$) (equation 2) from the test speed during the spinning cycle (205) is calculated.

$$(h_{deviation(205)}) = (\sum_{I=1}^{N(k)} (I h_i - h_{test} I)) \qquad \text{(Equation 2)}$$

The value of deviation from the test speed obtained ($h_{dev(205)}$) is compared to the values obtained in the reference measurement found during the production stage and recorded to the microprocessor, and the unbalanced load values in the unloaded drum are found. These values correspond to the smallest amount of unbalanced load with respect to other balanced load positions. In case this value is not sufficient to allow topass to the rinsing cycle, the drum is stopped before passing to the algorithm of determining balanced load, and the distribution step (A) is restarted after increasing the number (m) of distribution revolutions by one more revolution. If the level is still above the limit determined by the manufacturer, said distribution step (200) is repeated "m_{max}" times as defined by the manufacturer. In case of a failure, the procedure is terminated. If such a restriction is not seen, pre-spinning step (300) starts after the distribution step (200), (B).

In the pre-spinning step (300), a prespinning speed rate which is almost 2 fold the resonance spinning speed, is attained in a short time, with a high acceleration rate (301). This high acceleration, which is also referred to as the ramp, serves to avoid the moment of the washing machine or the crashing of the components in the machine by passing the resonance frequencies rapidly. Spinning is performed for a certain period at the prespinning speed ($t_{settling\ (302)}$) (302). This period ($t_{settling\ (302)}$) ensures both the running of the drum in the prespinning speed, and that water has been evacuated in such an amount that an excessive impact between the tank and the drum is avoided. At the end of this operation, an environment with the laundry closely stuck on the inner peripheral wall of the drum, and with a minimum friction between water-drum-tank and laundry-glass cabin door, will be available.

After the time period for staging in the prespinning speed (302) corresponds to the settling period ($t_{settling\ (302)}$), during the prespin-test period ($t_{prespin\text{-}test}=(t_i + t_k)$) the rms (root mean square) voltage (V_{rms}) applied to the motor in order to provide a spinning at the prespinning speed, is calculated. The proportion between the rms voltage (V_{rms}) and the rms input voltage ($V_{rms\text{-}input}$), corresponds to a certain firing angle (α) used for adjusting the motor voltage AC-motor phase angle controlled drive systems or to the dutycycle (Ψ) in systems with DC chopper (Equation 3).

$$(V_{rms})= (V_{rms\ input}) \times (\Psi) \qquad \text{(equation 3.1)}$$

$$(V_{rms}) = (V_{rms\ input}) \times (((\pi-\alpha)/2+\sin(2\alpha)/4)/\pi) \qquad \text{(equation 3.2)}$$

In these measurements, the error function created by the speeds at any moment (q) (E(q)) and (D(q)) are used in the function (f) defining PI, in order to obtain (α) and (Ψ) values.

$$E(q) = (h_q - h_{reference\ speed}) \qquad \text{(equation 4.1)}$$

$$D(q+1) = f\{(E(q), E(q-1), (D(q))\} \qquad \text{(equation 4.2.1)}$$

$$\alpha(q+1) = f\{(E(q), E(q-1), (D(q))\} \qquad \text{(equation 4.2.2)}$$

There is a relationship between the amount of unbalanced load (DY) and the amount of rms voltage to be applied. The voltage increases as the unbalance increases.

After the prespinning rate, a fall in the test spinning rate is provided (303). While measuring the time period during this fall the spinning rate, ($t_{fall}=(t_p - t_r)$), various speed measurements are taken sequentially so that the test speed is attained without falling below the determined test speed. This time period (t fall) is directly proportional with the time constant of the system, and therefore with

the moment of inertia. When the test speed is attained, the number of revolutions the measurement of the speed values is carried on.

$$(h_{\text{deviation (304)}}) = \left(\sum_{i=1}^{N(k)} (I\, h_i - h_{\text{test}}\, I)\right) \qquad \text{(Equation 5)}$$

After the settling period ($t_{\text{settling (304)}}$) it is measured again at the test speed ($h_{\text{deviation (304)}}$). The test speed measurement value ($h_{\text{deviation (304)}}$), time of entry to the test speed band during the controlled decrease of speed from the prespinning speed to the test speed (t_{fall}) is transferred to the equations with more that one undefined constant values ($S_1,S_2,S_3,S_4,.,S_{1,1},S_{1,2},S_{1,3},S_{1,4}..$), which determines the load, by means of the firing angle (α) or of dutycycle (Ψ) that determine the voltage applied to the motor at the prespinning speed; and the load (Y), unbalanced load (DY) values are obtained.

In another embodiment of the invention, the average ($h_{\text{deviation(304)}}$) and (($h_{\text{deviation(205)}}$) test speed measurement values is used instead of using only the test speed measurement value ($h_{\text{deviation(304)}}$).

Y= Load

$t_{\text{fall}} = (t_p - t_r)$= time of falling from prespinning speed to test spinning speed

$h_{\text{deviation(304)}}$ = standard deviation value of the test speed

Ψ = working rate

α= firing angle

DY= Unbalanced Load value

($S_1,S_2,S_3,S_4,.,S_{1,1},S_{1,2},S_{1,3},S_{1,4}..$)= constant values of the equation

(Equation 6.1)

$$Y = (S_1) + (S_2)(t_{\text{fall}}) + (S_3)\,(h_{\text{deviation(304)}}) + (S_4)\,(\Psi)$$

(Equation 6.2)

$$Y = (S_1) + (S_2)(t_{fall}) + (S_3)(h_{deviation(304)}) + (S_4)(\alpha)$$

(Equation 7.1)

$$DY = (S_{1,1}) + (S_{1,2})(Y) + (S_{1,3})(h_{deviation(304)}) + (S_{1,4})(\Psi)$$

(Equation 7.2)

$$DY = (S_{1,1}) + (S_{1,2})(L) + (S_{1,3})(h_{deviation(304)}) + (S_{1,4})(\alpha)$$

The load (Y) value is determined after the equation 6.1 or 6.2 is solved by means of the constant values (S1, S2, S3, S4 ....) to which the data received are entered end which is recorded in the data storage unit after being found by the experimental data. The load value (Y) and other data collected, are placed in the equation 7.1 or 7.2 and solved by means of the constant values (S1, S2, S3, S4 ....) to which the data received are entered and which are obtained by the experimental data and recorded in the data storage unit, and thus the unbalanced load value (DY) is obtained. The unbalanced load (DY) value is found by using the equation 6.1 and 7.1 in systems with DC chopper, and by using the equation 6.2 and 7.2 in systems with AC phase control. After comparing the parameters and measurement values calculated from the results of the reference experiments made during the design and production stages, which are recorded in the data storage unit and the experimental data defining the spinning rates corresponding the unbalanced load (DY) value obtained as the result of solving the equations {(equation 6.1 or 6.2), (equation 7.1 or 7.2)}, the microcontroller determines the spinning profiles, including such parameters as the speed, time etc. to define the speed rates and durations of the spinning according to the state of the unbalanced load (C).

Options for spinning profiles comprises the spinning stages (400) such as:

- Reaching the ultimate speed following certain steps (D),
- Applying said steps the limit that is permitted by the unbalanced load (DY) (E),
- Repeating the method of determining the unbalanced load, by applying a prespinning cycle with a low rpm (F),
- Returning to the distribution step by increasing the no. of revolutions (n) that define the no. of repeating the method of determining the unbalanced load, by one; provided that it does not exceed the value (n_{max}) determined by the manufacturer (A),
- In cases when the amount of unbalanced load (DY) does not fall below the value determined by the manufacturer (n>n max) or when said amounts is below the limit determined by the manufacturer, no-spinning (G) and stopping.

In an embodiment of the method of determining the unbalanced of the load present invention, a test speed rate of 100 rpm and a prespinning speed rate of 400 rpm are applied for a domestic appliance having a resonance frequency of approximately 200 rpms (Fig. 2).

With the method of determining the unbalanced load according to the present invention, the balanced and unbalanced loads at the beginning of spinning will be determined accurately and suitable distribution or spinning algorithms can be employed. It will be possible to develop washing machines with higher load capacities at smaller volumes. As reliable and efficient spinning profiles are provided, such problems that may arise due to spinning, as opening of the drum, bearing fractures, wearing of the damper, etc. are avoided and the service load can be decreased. Furthermore, by virtue of the reliable and efficient spinning profiles

provided by the method according to the invention, a reduction in uses for testing purposes under design or production conditions as well as strength is provided.

CLAIMS

1. A method for determining the unbalanced load, that provides the domestic appliances, preferably those of the front-loading type, in which the clothes to be washed defined as "the load" are placed, with an efficient, reliable spinning performance that causes no damage, by determining accurately the balanced and unbalanced loads during the spinning cycle, providing spinning cycles at spinning rates wherein the centrifugal forces and vibrational amplitudes to be created by the balanced and unbalanced loads are within acceptable ranges and/or providing a more efficient spinning performance, which comprises the steps of;

- draining the remaining water in the washing machine drum after the completion of the washing cycle, before each spinning, until it reaches to a point below a certain level (100),
- bringing the unbalance to a balanced state by providing the distribution of the load in the drum by rotating the drum in clockwise, counter-clockwise direction and stopping it (200),
- attaining a prespinning speed rate which is greater than the resonance speed rate in a short time by a high acceleration rate, from a test spinning rate that is much lower than that of the resonance speed, resonance frequency rapidly; which will cause the laundry to stick onto the inner peripheral walls of the drum and avoid the displacement of the washing machines which running, as well as crashing of the components in the machine (301),
- finding a firing angle value (α) in AC motor drive systems with phase angle control or a dutycycle (Ψ) in the systems using DC choppers, at the prespinning speeds, by calculating the rms voltage applied on the motor in order to enable the spinning performance at the prespinning speeds (302),
- after the prespinning speed, providing a fall to the test spinning speed rate by measuring the duration of the fall (t_{fall}) (303),

- measuring and calculating the value of deviation ($h_{deviation\ (304)}$) from the test speed (304)
- calculation of the balanced loads (Y) and unbalanced loads (DY) by making use of one or more constant values (S_1, S_2, S_3, S_4..., $S_{1,1}$, $S_{1,2}$, $S_{1,3}$, $S_{1,4}$...) to which the data received are entered and which are obtained by the experimental data and recorded in the data storage unit obtained from the firing angle (α), or dutycycle (Ψ), fall time (t_{fall}) calculated from the test speed deviation value ($h_{deviation\ (304)}$) , (C)
- comparing the parameters and measurement values calculated from the results of the reference experiments and the unbalanced load (DY) value obtained, in order to determine the spinning profile that should be applied at that moment (C),
- performing an efficient and reliable spinning according to the unbalanced load (DY) values obtained during the prespinning step.

2. A method for determining the unbalanced load as defined in Claim 1, comprising the steps of:
- performing spinning at the prespinning speed rate during settling period ($t_{settling\ (302)}$) in order to provide an environment with the laundry closely stuck on the inner peripheral wall of the drum, and with a minimum friction between water-drum- tank and laundry- glass cabin door and to ensure both the running of the drum in the prespinning speed, and that water has been evacuated in such an amount that excessive impact between the tank and the drum is avoided (302),
- making use of a relationship between the rms voltage (V_{rms}) and the rms input voltage ($V_{rms\ input}$), during an prespin-test period ($t_{prespin\text{-}test}$) when the rms voltage (V_{rms}) applied to the motor in order to provide spinning at the prespinning rate, is calculated while obtaining the rms firing angle (α) is found in the prespinning step,

$$(V_{rms}) = (V_{rms\ input}) \times (((\pi-\alpha)/2+\sin(2\alpha)/4)/\pi) \qquad \text{(equation 3.2)}$$

3. A method for determining the unbalanced load as defined in Claim 1, comprising the steps of:

- performing spinning at the prespinning speed rate during a settling period ($t_{settling\ (302)}$) in order to provide an environment with the laundry closely stuck on the inner peripheral wall of the drum, and with a minimum friction between water-drum- tank and laundry- glass cabin door and to ensure both the running of the drum in the prespinning speed, and that water has been evanated in such an amount that excessive impact between the tank and the drum is avoided (302),
- making use of a relationship between the rms voltage (V_{rms}) and the rms input voltage ($V_{rms\ input}$), during an prespin-test period ($t_{prespin\text{-}test}$) when the rms voltage (V_{rms}) applied to the motor in order to provide spinning at the prespinning rate, is calculated while

$$(V_{rms}) = (V_{rms\ input}) \times (\Psi) \qquad \text{(equation 3.1)}$$

4. A method for determining the unbalanced load as defined in Claim 1, while measuring and calculating the value of deviation from the test speed rate ($h_{deviation\ (304)}$); comprising the step of:

- when the test speed is attained, keeping the run in period ($t_{settling\ (304)}$) of the no. of revolutions at this speed (304) and measuring the speed values in order to calculate the standard deviation from the test speed values,

$$(h_{deviation\ (304)}) = \left(\sum_{i=1}^{N(k)} (I\, h_i - h_{test}\, I)\right) \qquad \text{(Equation 5).}$$

5. In the drive systems with dutycycle (Ψ) control, that use DC chopper, a method for determining the unbalanced load as defined in Claims 1, 3 and 4, comprising the following steps while making the calculations of balanced load (Y) and unbalanced load (DY);

- finding the load (Y) value by solving the equation (6.1):

$$Y = (S_1) + (S_2)(t_{fall}) + (S_3)(h_{deviation(304)}) + (S_4)(\Psi) \text{ (Equation 6.1), and}$$

- finding the unbalanced load (DY) value by solving the equation (7.1);

$$DY = (S_{1,1}) + (S_{1,2})(Y) + (S_{1,3})(h_{deviation(304)}) + (S_{1,4})(\Psi) \text{ (Equation 7.1).}$$

6. In the drive systems with AC motor phase angle (α) control, a method for determining the unbalanced load as defined in Claims 1, 2 and 4, comprising the following steps while making the calculations of balanced load (Y) and unbalanced load (DY);

- finding the load (Y) value by solving the equation (6.2):

$$Y = (S_1) + (S_2)(t_{fall}) + (S_3)(h_{deviation(304)}) + (S_4)(\alpha) \text{ (Equation 6.2), and}$$

- finding the unbalanced load (DY) value by solving the equation (7:2);

$$DY = (S_{1,1}) + (S_{1,2})(Y) + (S_{1,3})(h_{deviation(304)}) + (S_{1,4})(\alpha) \text{ (Equation 7.2).}$$

7. A method for determining the unbalanced load as defined in Claims 1-6;comprising the steps of:

- rotation in the counter-clockwise direction, at the washing speed (202),
- stopping and waiting for a while (203)
- rotation in the clockwise direction, at the washing speed (201),
- attaining a test spinning speed rate that is much lower than the resonance spinning speed rate, which will cause the laundry to stick to the peripheral walls of the drum in long time range, at a low acceleration rate (204),
- waiting for a while (turning (205)) ($t_{settling(205)}$) so that the rotational speed can run in the test speed, when the said test speed is attained (205)
- taking speed measurements at the test speed along the "k" number of revolutions to obtain sufficient statistical data and the desired unbalanced

load decomposition by using the function N(k) formed by the coefficient of the tachogenerator value and the belt-pulley revolution ratio (205),

- calculating and adding the absolute value deviations of the speed values measured (h_i) from the test speed (h_{test}) ($I\ h_i - h_{test}\ I$), and thus calculating the deviation ($h_{deviation\ (205)}$) created during the spinning at the test speed plate (205)

$$(h_{deviation\ (205)}) = \left(\sum_{i=1}^{N(k)} (I\ h_i - h_{test}\ I)\right) \qquad \text{(Equation 2).}$$

- comparing the deviation value ($h_{deviation\ (205)}$) from the test speed obtained with the values obtained in the reference measurements taken in design and production stages, and finding the amount of unbalanced load that they correspond in an empty drum,
- stopping the drum, in case this value is not sufficient to allow to pass to the spinning cycle and if the number of distribution cycles (m) is smaller than (m_{max}) which is determined by the manufacturer, restarting the distribution step (A) after increasing the number (m) of distribution revolutions by one more revolution;
- terminating the process if the number of revolutions (m) is equal to or greater than the no. determined by the manufacturer (m_{max}),
- if no restrictions are seen, passing from the distribution step (200) to the prespinning step (300) (B);

so that the water discharge process continues at various times and durations during the distribution step (200).

8. A method for determining the unbalanced load as defined in Claims 1-6, comprising a priming step (D), wherein spinning is made up to according to the unbalanced load (DY) values found during the prespinning step of the spinning cycle (400).

9. A method for determining the unbalanced load as defined in Claims 1-6,comprising a priming step (E), wherein spinning is made up to the limit allowed by the unbalanced load according to the unbalanced load (DY) values found during the prespinning step of the spinning cycle (400).

10. A method for determining the unbalanced load as defined in Claims 1-6, comprising a spinning step (F) wherein spinning is performed by a prespinning at a low rpm and by repeating the distribution stage, according to the unbalanced load (DY) values found during the prespinning cycle, at the spinning stage (400).

11. A method for determining the unbalanced load as defined in Claims 1-6, comprising the steps of:

- returning directly to the distribution step (A) by increasing one revolution, provided that the number (n) of the cycle that defines the number of repetitious of the method of determining the unbalanced load does not exceed the value (n_{max}) determined by the manufacturer,
- not performing any spinning, in case the number (n) of the cycle that defines the number of repetitious of the method of determining the unbalanced load ($n>n_{max}$)

when the unbalanced load (DY) amount found before passing to spinning cycle (400) is above the value defined by the manufacture.

12. A method for determining the unbalanced load as defined in Claims 10-12, that comprises the step of;

- using the test speed measurement values of ($h_{deviation(304)}$) and ($h_{deviation\ (205)}$) instead of using only the test speed measurement value ($h_{deviation\ (304)}$), while calculating the load (Y), unbalanced load (DY).

13. A method for determining the unbalanced load as defined in Claims 1, comprising the step of;

attaining a prespinning speed which is approximately two fold the resonance spinning speed (301).

14. A domestic appliance comprising a drum in which the clothes to be washed defined as "the load" are placed, a motor which drives the drum to perform the washing and spinning operations by rotating about an axis; a tachogenerator which is connected to the said motor; at least one microcontroller that transfers the AC voltage generated form said tachogenerator, as speed data after being converted to square waves, that controls the washing machine, that identifies the periods defining the number of revolutions of the drum in order to enable the calculation of the firing angle (α) arranged by means of the PI controller, the drive of the motor at desired rpms, the use and interpretation of the data obtained from the motor in a time-dependent manner and the interpretation and comparison of the data collected; and an electronic control card that comprises internally, externally or in the microcontroller at least one data storage unit in order to store the experimental data entered by the manufacturer and determined during the manufacturing or design stages; and which provides a method for determining the unbalanced load as defined in Claims 1-13 by, determining accurately the balanced and unbalanced loads during spinning, in cases when the total load capacity loaded in the drum increases and when the spinning rate exceeds the resonance speed, by precise unbalanced load measurement obtained through the analysis of the data collected by means of the control card during the operation of the machine, using the microcontroller, according to the experimental data recorded in the data storage unit, and thus enabling the performance of spinning at spinning rates with acceptable centrifugal forces and vibration amplitudes that may be created by the balanced and unbalanced loads, and/or enabling the spinning to be made more efficiently, so that the washing machine can perform the spinning process in a more efficient, more reliable way, without any damages.

15. A domestic appliance comprising a drum in which the clothes to be washed defined as "the load" are placed, a motor which drives the drum to perform the washing and spinning operations by rotating about an axis; a tachogenerator which is connected to the said motor; at least one microcontroller that transfers the DC voltage generated form said tachogenerator, as speed data after being converted to square waves, that controls the washing machine, that identifies the periods defining the number of revolutions of the drum in order to enable the calculation of the average dutycycle (Ψ) arranged by means of the PI controller, the drive of the motor at desired rpm.s, the use and interpretation of the data obtained from the motor in a time-dependent manner and the interpretation and comparison of the data collected; and an electronic control card that comprises internally, externally or in the microcontroller at least one data storage unit in order to store the experimental data entered by the manufacturer and determined during the manufacturing or design stages; and which provides a method for determining the unbalanced load as defined in Claims 1-13 by, determining accurately the balanced and unbalanced loads during spinning, in cases when the total load capacity loaded in the drum increases and when the spinning rate exceeds the resonance speed, by precise unbalanced load measurement obtained through the analysis of the data collected by means of the control card during the operation of the machine, using the microcontroller, according to the experimental data recorded in the data storage unit, and thus enabling the performance of spinning at spinning rates with acceptable centrifugal forces and vibrational amplitudes that may be created by the balanced and unbalanced loads, and/or enabling the spinning to be made more efficiently, so that the washing machine can perform the spinning process in a more efficient, more reliable way, without any damages.

Figure 1a

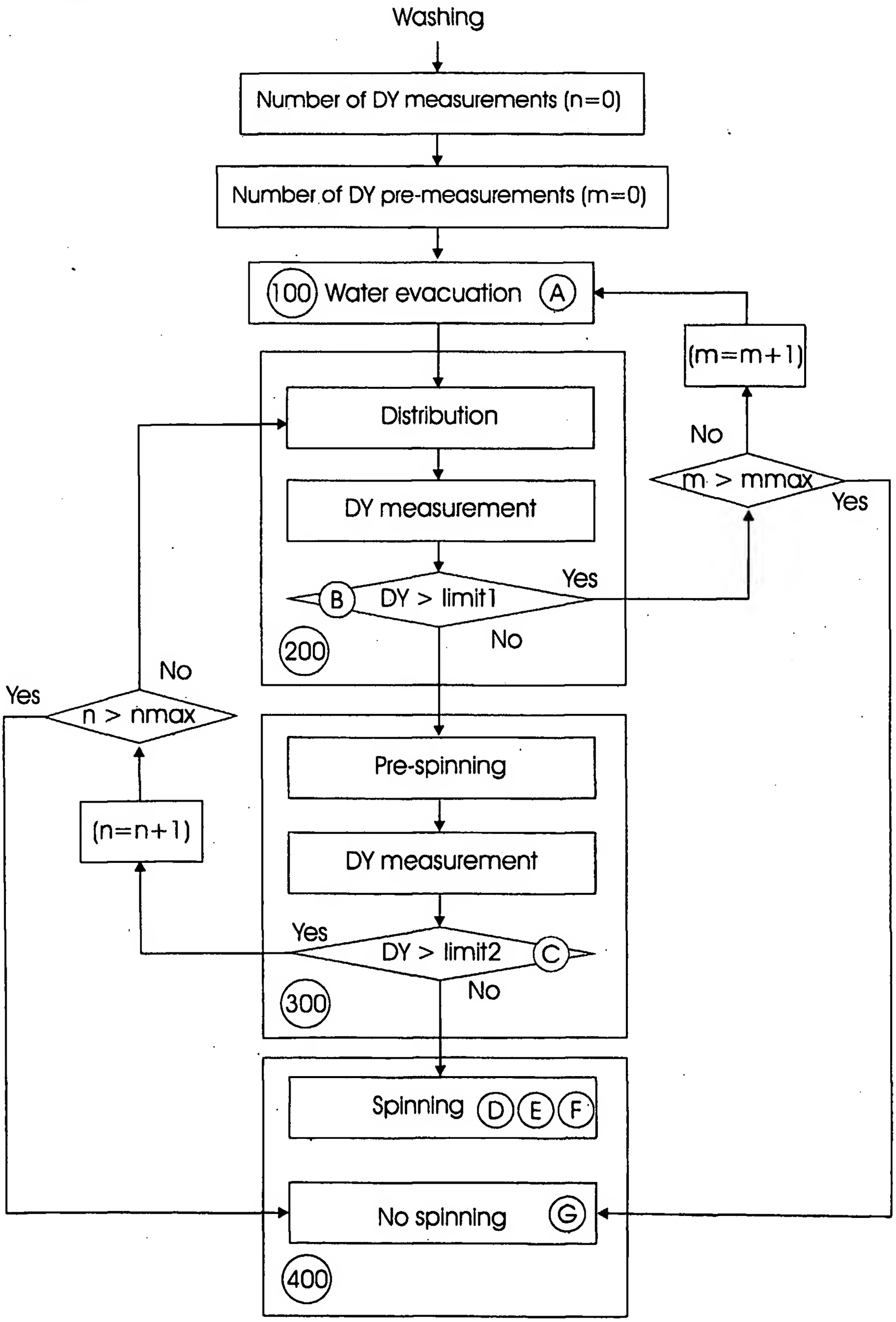

Washing
Number of DY measurements (n=0)
Number of DY pre-measurements (m=0)
100 Water evacuation A
Distribution
DY measurement
B DY > limit1
Yes
No
200
(m=m+1)
No
m > mmax
Yes
No
Yes
n > nmax
(n=n+1)
Pre-spinning
DY measurement
Yes
DY > limit2 C
No
300
Spinning D E F
No spinning G
400

Figure 1b

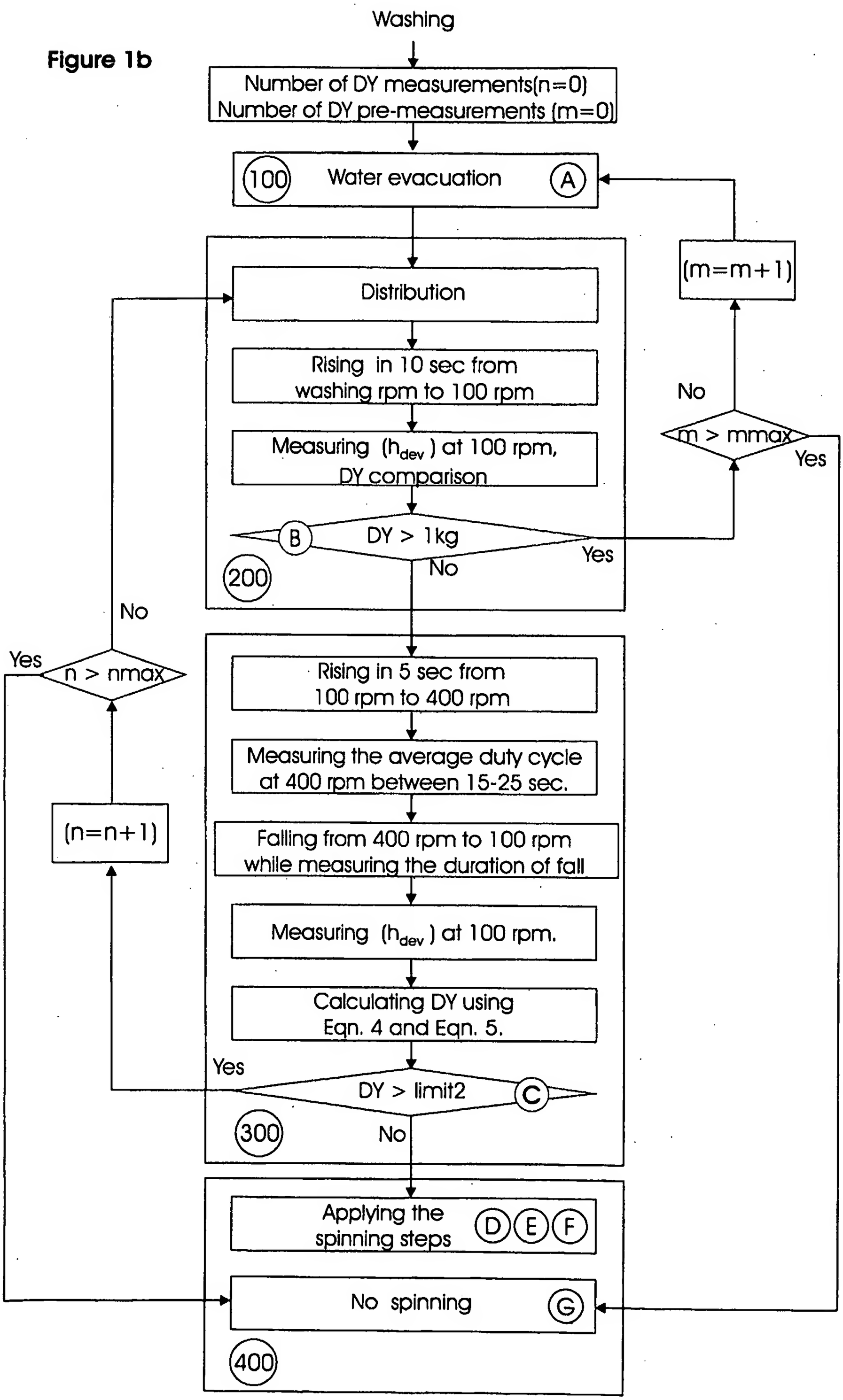
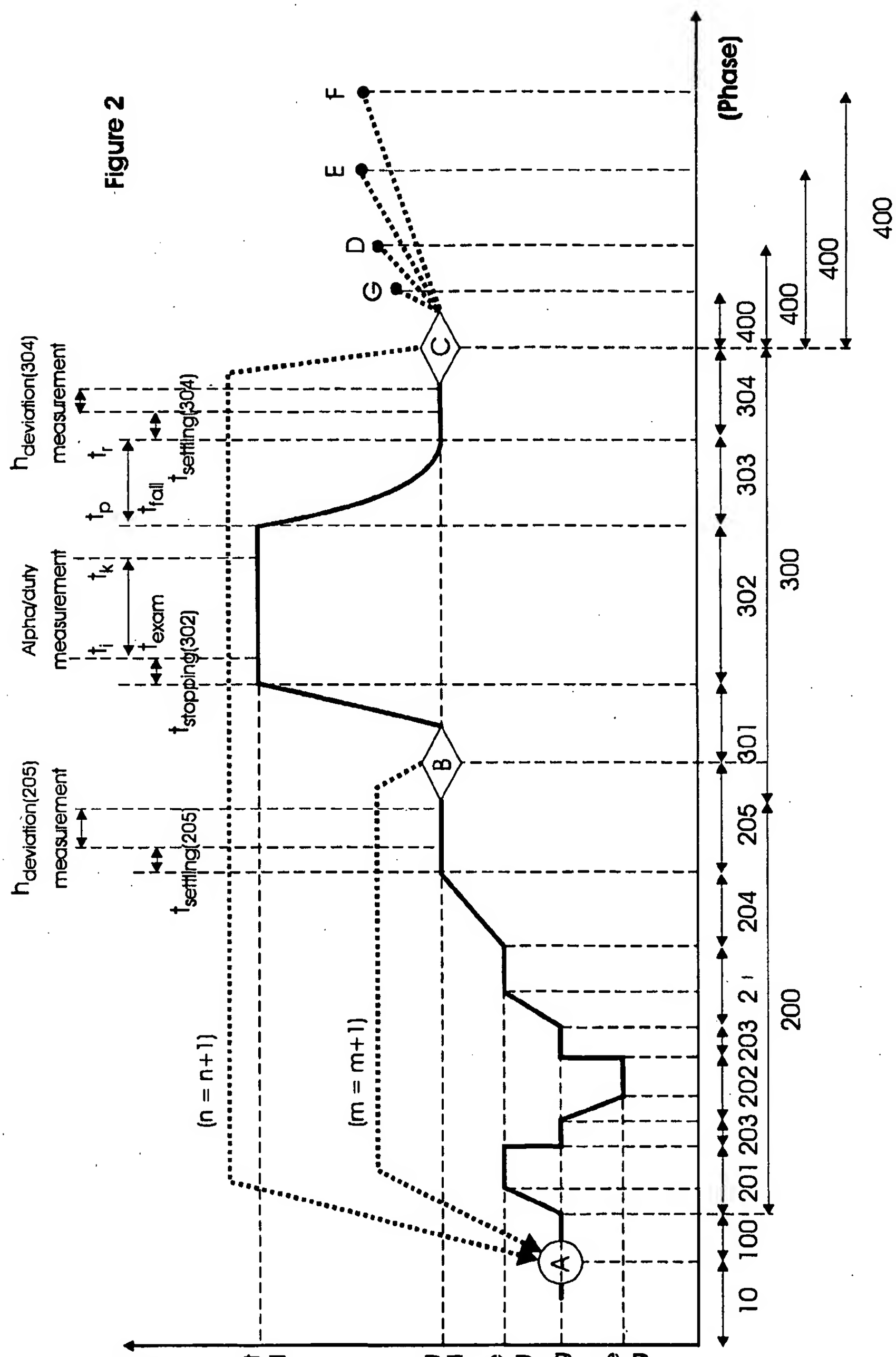

Washing
Number of DY measurements(n=0)
Number of DY pre-measurements (m=0)
100
Water evacuation
A
Distribution
Rising in 10 sec from
washing rpm to 100 rpm
Measuring (h_{dev}) at 100 rpm,
DY comparison
B
DY > 1kg
Yes
No
200
(m=m+1)
No
m > mmax
Yes
No
Yes
n > nmax
(n=n+1)
Rising in 5 sec from
100 rpm to 400 rpm
Measuring the average duty cycle
at 400 rpm between 15-25 sec.
Falling from 400 rpm to 100 rpm
while measuring the duration of fall
Measuring (h_{dev}) at 100 rpm.
Calculating DY using
Eqn. 4 and Eqn. 5.
Yes
DY > limit2
C
300
No
Applying the
spinning steps
D
E
F
No spinning
G
400

Figure 2


(Phase)
F
E
D
G
C
B
A
400
400
400
400
304
303
302
301
205
204
203
202
201
100
10
300
200
$h_{deviation(304)}$ measurement
t_r
t_p
t_{fall}
$t_{settling(304)}$
Alpha/duty measurement
t_k
t_i
t_{exam}
$t_{stopping(302)}$
$h_{deviation(205)}$ measurement
$t_{settling(205)}$
(n = n+1)
(m = m+1)
(Number of revolutions)
Spinnig at pre-spinning speed
Spinning at test speed
Clockwise washing
Stopping
Counter-clockwise washing

INTERNATIONAL SEARCH REPORT

International Application No
PCT/TR 02/00068

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 D06F37/20 D06F35/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 D06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 43 36 349 A (BOSCH SIEMENS HAUSGERAETE) 27 April 1995 (1995-04-27) cited in the application the whole document ---	1,14,15
A	US 6 038 724 A (CHBAT NICOLAS WADIH ET AL) 21 March 2000 (2000-03-21) cited in the application the whole document ---	1,14,15
A	EP 1 113 102 A (WHIRLPOOL CO) 4 July 2001 (2001-07-04) cited in the application the whole document ---	1,14,15

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
3 April 2003	11/04/2003

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Int nal Application No
PCT/TR 02/00068

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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